Pearson New International Edition

Technology Strategy for Managers and Entrepreneurs

Scott A. Shane

First Edition

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FIGURE 3
Scenario Analysis

Scenario analysis generally examines best, worst, and intermediate scenarios.
Source: http://www.andertoons.com.

Scenario Analysis

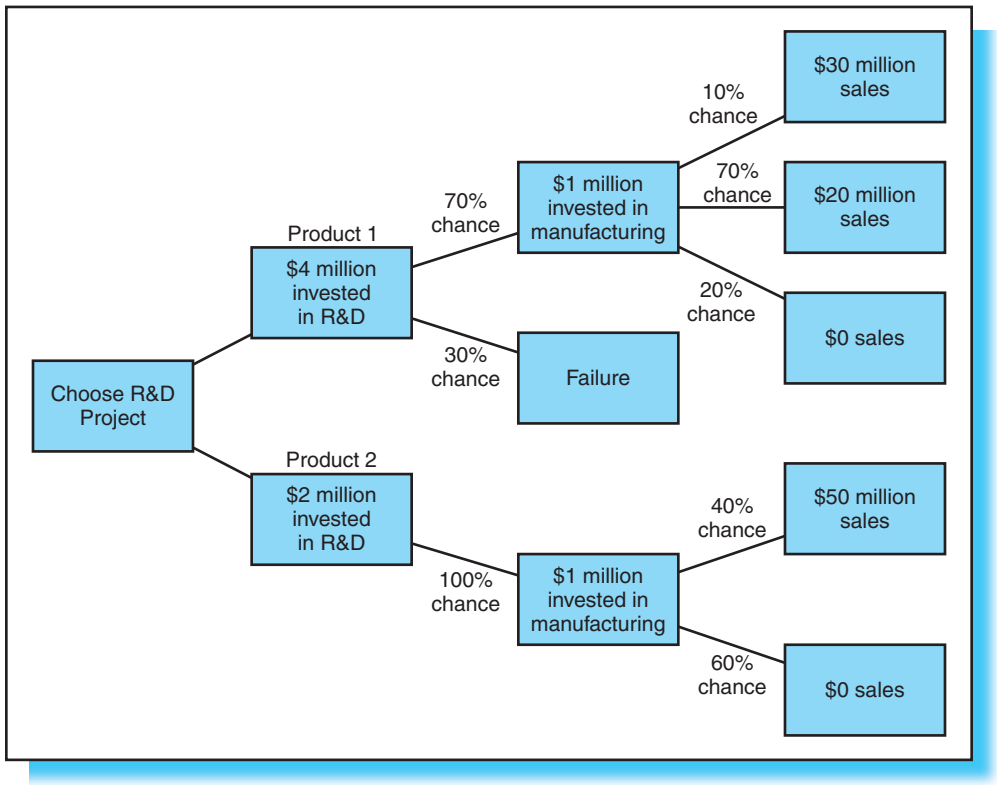
Another tool for making decisions about innovation projects is **scenario analysis,** which is the representation of investments under different assumptions about key factors that influence those investments (see Figure 3). Scenario analysis is useful because it helps you to identify the sources of uncertainty rather than assuming them away.[37] By making different assumptions about key variables affecting an innovation project, you can figure what uncertainties the project faces, what factors might lead things to go wrong, and what factors might drive desired outcomes.[38] As a result, you can partial out uncertain from certain outcomes and make decisions about the project more accurately.[39] For example, an entrepreneur writing a business plan for a business selling electronic books might create different scenarios for the business that considered whether complementary technology in electronic book readers could be developed at different points in time, and whether customers were as willing or less willing to read fiction and nonfiction books in electronic form as compared to paper.

Scenario analysis can be made more sophisticated by using **Monte Carlo simulation,** which is a way to create a probability distribution of outcomes through the use of computer software that experiments with randomly selected values of inputs.[40] With Monte Carlo simulation, you can look at the effect of tens of thousands of possible combinations of inputs on outcomes, rather than the effect of only a handful, thus generating more precise results from scenario analysis.

Decision Trees

Successful innovation also requires you to make accurate decisions about investments at different stages of the innovation process. The **decision tree**—a visual representation of decisions and their effects on outcomes, costs, and risks—is a tool that helps you to do that. For example, Figure 4 shows the decision tree for a choice between two possible innovation projects. The figure shows that project one will take twice as much R&D expense as project two and will have a 30 percent chance of failing, as compared to no chance for project two. Both projects then require a $1 million investment in manufacturing. The first project has an expected value of only $7.2 million. That is, −$4 million + (0.7 × −$1 million) + 0.7 × [(0.1 × $30 million) + (0.70 × $20 million) + (0.20 × 0)],

FIGURE 4
A Decision Tree



This figure shows a decision tree for the choice between two possible innovation projects.

while the second project has an expected value of $17 million. That is, −$2 million + −$1 million + [(0.4 × $50 million) + (0.6 × $0)]. The decision tree clearly shows that the second project is a better choice.

Decision trees provide a quantitative evaluation of a choice that is based on the value and probability of outcomes, and that accounts for the influence of staged decision making on risk. However, decision trees are limited by the use of discounted cash flows to calculate the branches on the trees, which makes them subject to all of the weaknesses of the use of discounted cash flows as a decision-making tool.[41]

Key Points

- Companies use quantitative and qualitative, and comparative and scoring, tools to select innovation projects to pursue; the different types of tools have different advantages and disadvantages.
- The checklist is a scoring model that evaluates projects on whether or not they meet specific criteria.
- The analytic hierarchy process is a decision-making tool in which a problem, like the adoption of a new technology, is broken down into a hierarchy of different criteria and choices.
- Many quantitative decision-making tools are based on the analysis of discounted cash flows; the two most common are net present value calculation, which estimates the value of a project today given the amount and timing of cash outflows and inflows and the discount rate; and internal rate of return

calculation, which estimates the rate of return on a project given the level of expenditure and the timing and amount of cash inflows and outflows.
- Real options are an important tool for selecting innovation projects that overcomes the weaknesses of decision making based on discounted cash flow calculations; they give the right, but not the obligation, to make future investments.
- Scenario analysis is a quantitative tool for making decisions about innovation projects that examines the effect of different assumptions about key factors.
- The decision tree is a visual representation of decisions and their effects on outcomes, costs, and risks; it helps you to make accurate decisions about investments at different stages of the innovation process.

Portfolio Management

When companies develop multiple products, they often use portfolio management tools to make decisions about innovation.[42] These tools help them to coordinate the different parts of the innovation process, set up the right order for those activities, and determine what resources are needed at different points in the process.[43] They also help decision makers to decide the order in which to pursue projects and the allocation of resources between them, given resource constraints.[44]

Portfolio management tools include any method that allows you to compare a set of projects against your strategic goals and to allocate scarce product development resources across the different projects.[45] They typically rely on some type of scoring system that allows you to compare and prioritize development projects along some dimension, such as financial return, strategic fit, or resource demands.[46]

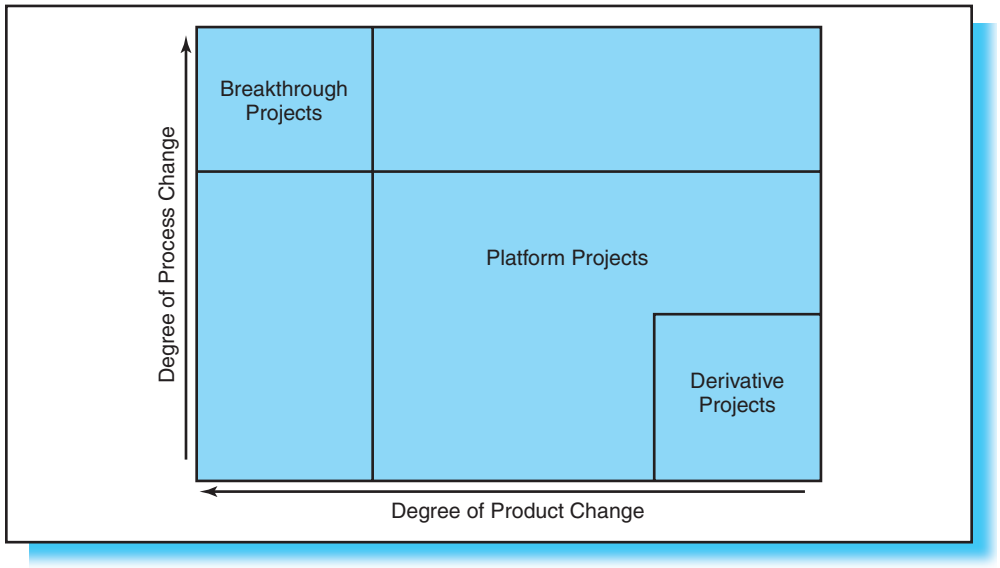
Portfolio models take a wide variety of forms, including pie charts and bubble diagrams, and can be based on either quantitative or qualitative analyses. However, **project maps** are the most important type.

As Figure 5 shows, project maps show the placement of projects into three different categories[47]—derivative projects (efforts that extend existing projects, like the development of Liquid Tide), platform projects (efforts to create new product families, like the Toyota Camry), and breakthrough projects (efforts based on fundamentally new ideas, like the development of the first digital camera).[48]

Project maps help you in several different ways. First, they link product development efforts to strategy.[49] Because project mapping helps to allocate resources across different types of projects, you can use it to manage your company's growth. If you want to accelerate growth, you can allocate more resources to platform and breakthrough projects; whereas if you want to maximize profits from your R&D investments, you can allocate more resources to derivative projects.[50]

Moreover, project maps help you to formulate the right product development plan, given your business strategy. You can use project maps to ensure that you have the resources and capabilities for the product development goals that you seek to achieve.[51] By analyzing the distribution of your product development projects across types, you can also use project maps to determine the number and mix of projects that you need to achieve your strategic goals.[52] For instance, a project map might reveal gaps in your efforts to develop breakthrough projects and lead you to allocate more human and financial resources to the development of those types of projects, rather than to derivative ones.

FIGURE 5
Mapping Product Development Projects



Mapping product development projects is a good way to ensure a balance between derivative, platform, and breakthrough projects because it helps technology strategists to visualize the allocation of resources across different types of innovation projects.

Source: Adapted from Wheelwright, S., and K. Clark. 2003. Creating project plans to focus product development. *Harvard Business Review,* September: 2–15.

This latter benefit of project maps is particularly important because you need to invest sufficient resources in platform and breakthrough projects for your company to achieve long-term growth.[53] However, your employees will be much more likely to propose derivative projects than platform or breakthrough projects. Without a mechanism to preserve your resources for other projects, derivative projects will use up all of your company's resources for innovation. Because project maps help you to define your company's allocation of human and financial resources across different types of projects, they force you to evaluate project ideas against an overall plan, which helps you to maintain nonderivative projects in your company's portfolio.

Second, project maps help you to avoid overcommitting your organization to innovation.[54] Companies often undertake too many innovation projects simultaneously, achieving less innovation than they would have achieved had they undertaken fewer projects. For example, in a study of its own innovation efforts, Exxon Chemical found that it would have had more and better innovation if it had cut in half the total number of projects it undertook.[55] Project maps allow you to measure how many projects you have underway at your company at any point in time, which helps you to avoid overcommitting your company to innovation.

Third, project maps help you to sequence your innovation projects to utilize your human resources effectively.[56] Research has shown that the productivity of engineers drops dramatically if they have to manage too many projects simultaneously.[57] Project maps provide information about your company's project allocation, which helps you to make better decisions about hiring product development personnel and assigning them to projects, thereby improving your human resource utilization.

Fourth, project maps help you to better manage your R&D personnel. Because engineers learn by doing, they can undertake more complicated innovation projects

GETTING DOWN TO BUSINESS

Medtronic's Use of Portfolio Management Tools[58]

Medtronic is a good example of a company that uses portfolio management tools. This Minnesota-based medical device company develops its products off of common platforms. For example, the company creates its cardiac pacemakers off of a hybrid integrated circuit platform, which allows it to make a variety of derivative products at low cost.[59]

It wasn't always that way. The company used to develop one product variant at a time, with no derivative products being offered. For instance, the company produced only one version of its very popular Activitrax pacemaker, even though different segments of the market were willing to pay different prices for versions with different features.[60]

However, the company's poor performance at product development led its management to require that all new products be designed so that derivative models could be created from a single platform.[61] The company then used the platform to reach all ends of the market, designing fully featured products to hit the high end of the market and products without some of the features and functionality for the middle and lower end. This approach allowed Medtronic to reach the low end of the market without doing what many companies have to do: cut prices on older models.[62]

The end result of this effort to create a platform strategy? An increase in the number of derivative products that were developed off of a single platform from 1 to 41.[63]

as they become more seasoned. As a result, you should first allocate new engineers to derivative projects, then move them to platform projects, and finally transfer them to breakthrough projects. Because project maps provide a layout of your company's projects, they facilitate the assignment of engineers to projects appropriate to their level of experience.[64]

Key Points

- Companies with multiple product lines and multiple products within those lines often use portfolio management tools to align their product development efforts with their technology strategies.
- A project map is a portfolio selection tool that helps you to manage the allocation of resources across platform, derivative, and breakthrough projects.
- Project mapping links product development efforts to firm strategy, helps companies to avoid overcommitment to innovation, facilitates the sequencing of product development efforts, and improves the management of product development personnel.

Discussion Questions

1. What strategies can firms adopt to manage uncertainty? What are the pros and cons of these strategies?
2. What are the advantages and disadvantages of different tools for evaluating innovation projects? When might qualitative tools be more appropriate than quantitative ones, and vice versa?
3. What is the analytical hierarchy process? When do you want to use it? How does it help you to make decisions about innovation projects?
4. What problems occur when discounted cash flow analysis is used to make decisions about innovation projects? What decision-making tools should be used if those problems are present? Why?
5. How does scenario analysis help you to make decisions about innovation projects? Why does scenario analysis help?

Key Terms

Analytic Hierarchy Process (AHP): A comparative model of project evaluation in which managers create a hierarchy of evaluation criteria.
Checklist: The most basic form of scoring model; projects are evaluated on whether or not they meet specific criteria.
Comparative Models: Decision-making tools that compare projects against each other.
Decision Tree: A visual representation of decisions and their effects on outcomes, costs, and risks that people can use to make decisions about ways to achieve a goal.
Fixed Costs: The costs that are not dependent on the volume produced.
Internal Rate of Return: A calculation of the payoff of a project, given the level of expenditure and the timing and amount of cash inflows and outflows.
Monte Carlo Simulation: A use of computer software to create a probability distribution of financial outcomes based on randomly selected values of inputs.
Net Present Value (NPV): An estimate of the financial value of a project today, given the expenditures, timing, amount of cash inflows and outflows, and the discount rate.
Project Map: A portfolio management tool that allocates projects into three types: derivative, platform, and breakthrough.
Qualitative Methods: Decision-making tools that compare projects on the basis of scales or words.
Quantitative Methods: Decision-making tools that select projects based on the basis of numerical calculations.
Real Options: A decision-making tool that is based on the idea that investments give the right, but not the obligation, to make future investments.
Scenario Analysis: A decision-making tool that represents investments under different assumptions about key factors that influence those investments.
Scoring Models: Decision-making tools that compare projects against standard scales.
Variable Costs: The costs that are dependent on the volume produced.

Putting Ideas into Practice

1. **Net Present Value Analysis** Your company is thinking of establishing a new semiconductor plant. It will cost you $1 billion to build the plant, all of which will be incurred in the first year. From the second through the fifth year, the plant will generate $250 million per year in revenue. At the end of the fifth year, the plant will become obsolete and will no longer generate any revenue. Your company pays 11 percent to borrow money. What is the net present value of this project? Does the net present value calculation indicate that you should pursue the project or not? Why?
2. **Real Options Analysis** Assume that you are a manager at a pharmaceutical company where researchers are working on a drug to treat heart disease. The cost of making the drug and the revenues that you will earn from selling an effective drug are uncertain because you don't know how effective the drug will be or what conditions the drug will treat. You need to conduct $1 million of R&D to develop the drug. If you are successful, you will have to undertake clinical trials that could cost either $25 million or $80 million, with a 50 percent chance of each type of trial occurring. If you succeed at clinical trials, there are two indications for the drug, each of which has a 50 percent chance of occurring—one which will generate $40 million revenue, and the other which will generate $60 million in revenue. Your company's cost of capital is 10 percent. Use the net present and real-options approaches to calculate the discounted cash flows for the project. What does each approach suggest that you do? Why?[65]
3. **Developing Project Maps** The purpose of this exercise is to develop a project map for General Motors. (For information on the company and the innovations that it is developing, go to www.gm.com.) Place the following projects on a project map for General Motors, identifying the breakthrough projects, platform projects, and derivative projects: hybrid diesel-electric busses, Chevy Tahoe and GMC Yukon hybrid cars, E85 flex-fuel vehicles, Chevy Volt electric car, Chevy Equinox fuel cell; engine power trains (e.g., LS7-V8 for the Corvette), marine power trains (e.g., Vortec 8100), Sit-N-Lift power seat; Onstar navigation system, active fuel management, variable valve timing, six-speed transmission, 1.8 Ecotec engine, and displacement on demand. Given the firm's strategy, is the allocation of projects across the three types correct? Why or why not? Should the company undertake additional projects? If so, what? Should the company allocate more resources to any of the existing projects? Why or why not? How does this project allocation influence what the firm will be able to do?